Wisconsin.—The mean temperature was 16.4°, or 4.5° below normal; the highest was 54°, at Milwaukee on the 10th, and the lowest, 29° below zero, at Osceola on the 2d. The average precipitation was 1.11, or 0.27 below normal; the greatest monthly amount, 2.69, occurred at Watertown, and the least, 0.10, at Spooner.—*W. M. Wilson.*

Wyoming.—The mean temperature was 19.5°, or 6.5° below normal; the highest was 70°, at Wheatland on the 31st, and the lowest, 33° below zero, at Sheridan on the 16th. The average precipitation was 0.91, or 0.27 above normal; the greatest monthly amount, 2.14, occurred at Fort Washakie, and the least, 0.24, at Lusk.—*W. S. Palmer.*

RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

The rise in the lower Mississippi which began in November continued very slowly during the first three weeks of December. During the last week of the month a sharper rise occurred, bringing the river to about its normal condition on the 31st at Cairo and Memphis. At Vicksburg the stage was still 8 feet below its normal height, but rising steadily.

The upper Mississippi and Missouri were closed by ice at the end of the month, and there has been practically no navigation on them since the last of November. The Ohio remained open and navigation was good, with scarcely any ice. The large coal shipments of November down the Ohio were duplicated. The Arkansas and Red continue very low, although slight rises toward the end of the month enabled a partial resumption of navigation.

During the last week of the month navigation was closed by ice in the Hudson. The navigable streams of the South Atlantic and East Gulf States have risen to fairly good stages and a marked increase in freighting has taken place.

The highest and lowest water, mean stage, and monthly range at 114 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on the accompanying chart, V. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

The following résumé of river stages and conditions of navigation in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations and section centers:

Hudson River. (Reported by A. F. Sims, Albany, N. Y.)—Heavy rains on the watershed during the early days of the month caused the Hudson River to rise 7.1 feet above mean low water by the morning of the 6th. The prevailing wind was from the north, and the river fell 2 feet by the morning of the 7th. No ice was present in the river on that date. A dense fog overhung the valley during the mornings of the 8th and 9th. On the 10th all up-bound boats from New York were delayed in consequence of fog. On the 14th all streams in eastern New York were high, and a special warning to the effect that the Hudson would overflow its banks was made public. The river rose 20 inches in three hours at Albany during the 15th and flooded Quay street; on the 16th a stage of 10.5 feet above mean low water was reached; and by the 16th there was 1 foot of water on the lower streets south of Madison Avenue. The *Dean Richmond* could not make her regular landing at Steamboat square, but tied up at the high dock at the foot of Gansevoort street. The river ran like a mill-race during the 16th, and the swollen current brought down huge masses of debris that had been piled up along shore. Merchants had prepared for such a freshet by removing goods out of reach of water. Trains ran through a foot of water on Quay street during the afternoon of the 15th. At 9:45 a. m. on the 15th there were 73 inches of water passing over the State dam at Troy, the highest record for December in many years. The mills in the northern part of Troy were partly shut down on account of high water.

The Hudson receded and was within its banks by the 17th. On the 20th the *Dean Richmond* left for New York City and navigation was brought to a close; the upper Hudson froze over on the 24th. The condition of the river for several days prior to its close was not favorable for a permanent winter freeze, as the waters swollen by the recent rains, had covered the various wharves that line both sides of the stream and, at the time ice began to form, was too high to allow the dirt to settle. The current was still rapid and the ice formed was lumpy, and barrier after barrier of drift ice found lodgment at various points along the river. Navigation on the lower Hudson closed on the 27th.

Susquehanna River. (Reported by E. R. Demain, Harrisburg, Pa.)—The rainfall within the drainage area of the Susquehanna River was above the average and, being fairly well distributed through the month, the good stages of water in the streams at the end of November were maintained throughout the greater part of December, but a majority of the stations report lower stages on December 31 than existed at the beginning of the month. The conditions as to rainfall and the quantity of water discharged differed materially from those of December, 1896. For that month the average gauge reading of twelve stations was 2.4 feet, and the average rainfall of sixteen stations 0.89 inch, while for December, 1897, the average gauge reading of fifteen stations was 3.2 feet and the average rainfall of sixteen stations 3.20 inches. The dates of the closing of streams are reported as follows: At Sinnemahoning, the 22d; at Farrandsville, the 24th; at Mifflin, the 25th; at Wilkesbarre, the 25th; and at Williamsport, the 25th. A sudden rise of 2.3 feet at Towanda on the 28th was supposed to be due to an ice gorge below, as no precipitation sufficient to cause such a decided rise was known to have occurred above this point. Slush ice appeared in the river at Keating on the 23d and at Harrisburg on the 24th, and continued running, in decreasing quantities, till the end of the month.

Rivers of the South Atlantic States. (Reported by E. A. Evans, Richmond, Va.; C. F. von Herrman, Raleigh, N. C.; L. N. Jesunofsky, Charleston, S. C.; D. Fisher, Augusta, Ga.; and J. B. Marbury, Atlanta, Ga.)—The volume of water in the James River and its tributaries was about normal throughout the month. The rainfall over the river basin, while generally a little in excess of the average, showed no marked departures, and as the soil was not frozen a considerable portion of the downpour was absorbed. The water remained at about the zero of the gauge until the 15th, when general rains occurred over the basin, producing a rise to 1.5 foot on the following day. This was the maximum stage for the month. The river then declined slowly to its former level, which height it maintained with unimportant fluctuations during the remainder of the month. Navigation was unimpeded throughout the month, and, while some ice formed in shallow water above the falls during the last decade, it was not sufficient to be of consequence. With a normal amount of precipitation for the month, falling chiefly from the 2d to the 4th, 12th to 15th, and 19th to 22d, somewhat higher river stages were maintained in the North Carolina streams during December. Moderate increase in the volume of flow occurred about the 7th, 18th, 24th, and 28th. On the latter date the highest stage, 10 feet above the zero of gauge, occurred at Fayetteville, on the Cape Fear. The Cape Fear maintained a mean stage 2 feet higher than during November, while there was no increase in the mean stage of the Dan. There was very little formation of ice during the month, and has been practically no accumulation of snow in the mountains.

Navigation on the streams of South Carolina during December was much improved over that of the preceding month. Though slightly deficient in amount, there was a uniform distribution of rain over the drainage areas, which caused most of the streams to rise slowly, and sufficiently for purposes of traffic, between the 1st and 24th. The widespread and copious precipitation of the 25th and 26th produced additional rises, so that by the end of the month the streams had reached their normal heights, and navigation was fully resumed. A comparison with the season of 1896 shows that the resumption of navigation this year was twenty-seven days later than in 1896. The Pedee at Cheraw was unnavigable from the 5th to the 22d.

The lumber season was at its height during the latter part of the month. There are thousands of cypress log and timber rafts lying along the banks of the streams awaiting favorable rises. A few light rafts were floated down the Pedee, the Little Pedee, the Waccamaw, and the Wateree, during the latter part of the month, but not with the success expected, for several rafts stuck fast in the shallow water upon the lower Black and lower Waccamaw rivers, and had to be pulled off by towboats. Twenty-three rafts of undressed lumber, the first this season, arrived at Charleston between the 14th and 21st from Edisto and other landings along the Edisto River.

While steamboat men and merchants are hopeful of business during the coming steamboat season, yet the great loss occasioned by low water during November and the first part of December has proven a great setback to them. Considerable cotton was transported by rail, which otherwise would have gone by steamer. The steamboat companies report a great decrease in the fertilizer business this winter and a corresponding increase in the rice trade and in naval stores.

There was a marked deficiency of rainfall during the month over the greater portion of the Savannah watershed, but even with this shortage a much better boating stage was maintained than prevailed during the previous three months. The lowest gauge reading occurred on the 13th, and was more than sufficient for all navigation purposes, and no difficulty was encountered at any time in making regular trips by the river boats. With little cotton remaining to be shipped and the merchants of Augusta pretty well stocked for the winter, only one boat was used for the accommodation of river traffic, the other regular steamer being withdrawn until the commencement of the spring trade.

More than the normal amount of rain fell in the drainage basins of northwest Georgia, but, owing to a very dry condition of the soil, comparatively little of the water reached the rivers, and low stages continue. The rainfall in the middle and southern sections of the State was very light. The rivers are all below the boating stage, and no business has been done in that line.

Mobile River and branches. (Reported by F. P. Chaffee, Montgomery, Ala., and W. M. Dudley, Mobile, Ala.)—The Alabama River was too low for traffic during the first decade of the month, but heavy rains during that period caused a general and gradual rise in the upper rivers, which was felt as far down as Selma by the 10th, after which well distributed rains at intervals of a few days caused navigable stages in the rivers of this system during the remainder of the month. On the 16th the first steamer since August 1 arrived at Montgomery from Selma and down-river points, and a large quantity of cotton was freighted by steamer between Montgomery and Mobile during the latter half of the month.

The moderate, general rain, which fell on the 2d, caused rises in the upper Tombigbee. Heavy rains on the 3d and 4th maintained the rise to the 6th, when falls over the headwaters were noted, but the rise continued to the 8th from Demopolis to the Gulf. General and heavy rain fell on the 13th and 14th, but had only a slight effect on the river stages, as the changes were very small from the 14th to the 21st, when the heavy rain which occurred on the mornings of the 21st, 22d, and 23d caused marked rises in the Warrior and Tombigbee rivers. A fall began on the 26th and continued to the close of the month.

The rivers at all points got above the zero of gauge during the early part of the month and so continued, giving as a rule good navigable stages, and a large business was done by the boats. On each trip they brought to Mobile immense cargoes of cotton, being loaded to their fullest capacity, to return with merchandise for the people living in the upper country.

Ohio River and minor branches. (Reported by F. Ridgway, Pittsburg, Pa.; H. L. Ball, Parkersburg, W. Va.; S. S. Bassler, Cincinnati, Ohio; S. P. Gresham, Louisville, Ky.; and P. H. Smyth, Cairo, Ill.)—The month of December was an exceptionally favorable one for navigation, a sufficient stage for packet traffic being maintained at all times on the Ohio, Alleghany, and Monongahela rivers, which were absolutely free from ice, except during the last few days of the month. There were two excellent boating stages which sufficed for the transportation of all the coal in the Pittsburg harbor and Monongahela river. The shipments of coal during the month were 10,560,000 bushels. During this period the Alleghany and its tributaries were also cleared of their timber product, all of which was run in safety to the market at Pittsburg. About the end of the month the Alleghany showed a tendency to close with ice at various points which, considering its heavy output of ice generally, will prove beneficial to the Ohio River navigation. While the conditions have thus far favored navigation they have been correspondingly unfavorable to the progress of river improvement in this vicinity. With the continuation of open weather the heavy snow now covering the Alleghany and Monongahela valleys should maintain the present water conditions for a considerable period.

At Wheeling the lowest stage during the month, 6.2 feet on the 6th, was followed by a quick, light rise which continued until the 9th. The river began rising again on the 13th and reached a maximum stage of 18.9 feet on the 17th. After this there was a slow fall to 6.9 feet during the closing days of the month.

At Parkersburg excellent boating stages were had throughout the month, the range of water being from 18.0 feet on the 19th to 7.7 feet during the last three days of the month. Ice began running on the 27th, and on the 28th and 29th was sufficiently heavy to impede navigation to some extent.

At Cincinnati and Louisville there was a good, navigable stage of water during the entire month, and river business was active. An average depth of water of 8 feet obtained in the canal at Louisville, ranging from 6.0 feet on the 1st to 10.1 feet on the 23d.

At Evansville from the 1st to the 20th the river alternately rose and fell every three or four days, making an uncertain stage with little variation. A rise from the upper river reached this point on the 20th, and during the subsequent five days the stage increased 9 feet. A fall set in on the 26th and continued at the close of the month.

At Paducah and Cairo the river improved slightly during the first and second decades. During the night of the 21st a rise out of the Tennessee reached Paducah, starting the river up at that point. By the 22d combined rises out of the Cumberland, Tennessee, and upper Ohio were passing Paducah and Cairo. This rise continued at Paducah until the 27th and at Cairo until the 28th. At the close of the month the Ohio was falling somewhat rapidly from Evansville down. A good boating stage obtained at Cairo during the second half of the month. Large tows of coal from the upper river, bound for the south, passed Cairo on the 21st, 26th, and 30th.

Tennessee and Cumberland Rivers. (Reported by L. M. Pindell, Chattanooga, Tenn., and H. C. Bate, Nashville, Tenn.)—General and heavy rain fell over the Tennessee River basin from the 2d to the 4th, causing a rise which opened navigation on the 5th, but it was closed again on the 9th. Light rain occurred at intervals from the 8th to 22d, which opened navigation again on the 20th. A good boating tide continued through the balance of the month, but at its close the river was falling with indications of a further closing of navigation. On December 6 a fleet of rafts arrived at Chattanooga from the Clinch River. Light driftwood passed on the 21st and 23d, and heavy drift on the 22d. The activity on the water front was marked in comparison with what it had been for the past four months. The rivermen think that the conditions are favorable for a continued boating tide.

The month opened with the Cumberland River low and navigation closed, but good rains on the 2d, 3d, and 4th were responsible for a material rise and the opening of navigation from the mouth of the river to Carthage and Celina. A rapid decline in the river shut off navigation above Nashville from the 10th to the 20th, when another good rain opened the river to the head of navigation long enough for one boat to make the trip. After the 24th navigation was closed above Celina, but the stage of water allowed one boat to leave for that point on the last day of the month.

Mississippi River and minor branches. (Reported by P. F. Lyons, St. Paul, Minn.; M. J. Wright, Jr., La Crosse, Wis.; G. E. Hunt, Davenport, Iowa; F. Z. Gosewisch, Keokuk, Iowa; H. C. Frankenfield, St. Louis, Mo.; P. H. Smyth, Cairo, Ill.; S. C. Emery, Memphis, Tenn.; R. J. Hyatt, Vicksburg, Miss.; and R. E. Kerkam, New Orleans, La.)—The rivers of Minnesota have remained frozen over during all of the month. The ice field in the Mississippi River in front of St. Paul was noted regularly at short intervals, and, judging from the rise and sag of the same, the average gauge reading for the month would be about 3.7 feet if it were possible to make gauge readings. Reports from commercial travelers and others justify the statement that there was little snow on the ground at the end of the month over the watersheds of the Minnesota and Upper Mississippi rivers.

The Mississippi River at La Crosse was completely closed on the 1st of December and remained closed during the entire month. Last season the river was not closed until January 24, nearly two months later than the present season. The early closing of the river this season was due to the low temperature which prevailed during the last four days of November, although the mean temperature for that month was normal and 6° above the mean temperature for November, 1896. The mean temperature for December was 17°, which is 6° below the normal and 9° below the mean for December, 1896. These conditions have resulted in a good ice crop, the quality of which is said to be the best for several years. The ice harvest began on the 28th. There was a deficiency of 0.64 inch in the monthly precipitation, with 3.4 inches of snow on the ground at the end of the month. An ice road was laid out on the river between Brownsville, Minn., and La Crosse on the 7th, and has greatly facilitated travel and trade.

From La Crosse to Leclaire the river was frozen during the entire month. At Davenport, though the river was more or less obstructed by ice, the ferryboat ran from the 10th to the 16th, and the ice did not stop running at the bridge until the morning of the 21st. The river remained open along the upper portion of the city until the 23d. On the 27th the ice was about a foot thick. At Muscatine, Iowa, the river was frozen from the 7th to the 13th, and again from the 16th to the end of the month. At Davenport the river was slightly higher than the average at the time of freezing, and the time of freezing was, perhaps, slightly earlier than usual, though near the average.

A decided fall in the stage of the river at Keokuk was caused by anchor ice forming on the Des Moines Rapids, and on the 6th the river was reported closed by ice at Burlington, Iowa, causing very low water to continue throughout the month. Heavy, broken, gorge ice was running at Keokuk on the 12th, and on the 16th the river was full of newly formed ice. The channel remained open until the night of the 22d, but the shore ice was 5 inches thick on the 20th. The river was closed at the end of the month with ice varying from 5 to 9 inches.

During the month the waters in the rivers of the St. Louis district were subjected to frequent and irregular fluctuations, due to the effects of the ice gorges and blockades above. The tendency, where the rivers were open, was toward a general fall, but this was often interrupted by the formation of local blockades at various points. Thus, at St. Louis there was an extreme range of 3.9 feet, but from the 1st to the 31st the net loss of water was only 1.6 foot. The rise during the last few days of the month was probably due to a slight gorge reported below, at Wittenberg. Ice, either floating or gorged, was present in all the rivers during practically the entire month. It commenced running past Grafton, Ill., on the 2d, and was first noticed at St. Louis on the 6th, four days later than in 1896. At the end of the month the Mississippi River was practically blocked as far south as the mouth of the Missouri. The Illinois River was blocked at Beardstown on the 17th and at Peoria and Grafton on the 18th, and still remains in that condition.

Ice cutting commenced as far south as Quincy on the 21st and at Alton on the 22d, but was suspended as far north as Burlington a few days later, owing to softening of the ice caused by rising temperature. Navigation north of St. Louis was suspended on the 3d; from St. Louis southward navigation was practically suspended on the 18th. During the month the wreck of the towboat *Dolphin No. 2*, which was sunk by the tornado of May 27, 1896, was almost entirely removed by the United States Engineer Corps, and there is at the present stage of the river about 9 feet of water over the remaining portion of the wreck.

From St. Louis to Cairo the river fell during the first decade of the month, followed by a slight rise until the morning of the 17th. A sharp fall set in on the 19th and continued until the 24th, bringing the river down to a lower stage than there is any previous record of. At Chester the gauge reading on the 24th and 25th was 1.9 foot below the zero of gauge. The previous lowest record at Chester was 1.8 foot below zero on January 15, 1892. At Chester the river was full of floating ice on the 5th and continued so until the 9th. A second run of ice commenced at Chester on the 18th and continued until the 28th. Light ice commenced running at Cairo during the afternoon of the 21st; filled the river during the night, and continued running until the night of the 24th. A second run of ice commenced passing Cairo on the 31st. The ferry crossing the Mississippi between Cairo and Greenfield, Mo., suspended on the 24th on account of ice. The last regular freight boat from St. Louis arrived at Cairo on the 4th. On the 12th and 18th small tows arrived from St. Louis. After the 18th navigation was entirely suspended between Cairo and St. Louis. Several steamers and towboats are still laid up at Cairo on account of low water in the Mississippi.

Between Cairo and Helena the river remained at a moderately low stage with slight fluctuations up to the 22d. On that date the stage at Memphis was 5.1 feet, an increase of only 2 feet since the 1st. A rise coming out of the Ohio was first felt at Cairo on the 22d, and reached a maximum of 19.3 feet at that place on the 28th. This swell, which at Cairo amounted to 10.4 feet, caused a rise of 7.1 and 10.4 feet, respectively, at Memphis and Helena, and culminated at Memphis on the 3d day after the crest passed Cairo. By this rise the stage at Memphis was increased to 12.4 feet, and that at Helena to 16.4 feet. This is a good boating stage, and is being taken advantage of by coal dealers in bringing down some large fleets of coal barges that have been held back by the low water. The monthly average stage for December at the Memphis gauge was 5.5 feet, which is about 5.5 feet below the normal reading, and a lower average has seldom occurred. It was nearly 6 feet below the December average for 1896. Owing to the low water in the tributaries navigation on those streams was practically suspended during the month except to very small boats.

Good boatable water was reported during the greater portion of the month between Helena and Vicksburg, and river traffic, both freight and passenger, was very good during the month. Traffic on the upper White River was suspended at the close of the month. The rise in the Mississippi put all sandbars under, and greatly benefited steamboats, which are still coming in heavily loaded with cotton. Many of the sandbars caused considerable trouble during low water, especially the bar in front of Greenville. Boats are having less trouble in unloading as the high banks are not so steep. Considerable drift passed down the Mississippi during the past two weeks. Good traffic was reported on the Yazoo and tributaries since about the 7th, when sufficient water had appeared to allow boats to cross the bar at the confluence with the Mississippi. Heavy rains afforded sufficient water for all river interests on the Yazoo and its tributaries, the river rising above zero on the gauge at Yazoo City on December 3. At Vicksburg the river rose above zero on the 4th.

The Mississippi between Vicksburg and New Orleans rose quite rapidly during the first and last decades of the month. Below New Orleans the fluctuations were not very marked, the range for the month reaching barely 2 feet.

Missouri River. (Reported by L. A. Welsh, Omaha, Nebr.; P. Connor, Kansas City, Mo.; and H. C. Frankenfield, St. Louis, Mo.)—At and above Omaha the Missouri River and its tributaries remained frozen throughout the month. An average thickness of ice of about 10 inches was maintained during the month at Omaha, the ice being thickest on the 18th, when a measurement showed 15 inches. The river froze at Plattsmouth on the 1st and continued frozen the remainder of the month. The Burlington and Missouri River Railroad Company did considerable filling and mattressing at the east end of the Burlington bridge in the earlier part of the month. Eight inches of snow on the ground were reported from that point on the 3d. The river was reported frozen throughout the month at St. Joseph, Mo.

The Missouri River froze at Kansas City on December 5, and opened again on the 7th, remaining open until the 20th, when it again closed until the 26th, after which it was open until the end of the month, with a slightly higher stage than at the beginning of the month. The ice was thickest on the 20th, its thickness then being 5 inches. On neighboring lakes it was from 7½ to 8½ inches thick.

Ice commenced running past Hermann, Mo., on the 2d. Temporary ice blockades occurred at Glasgow and Washington, Mo., on the 20th, and at Hermann on the 25th. The Osage River was also blocked at Bagnell, Mo., on the 22d. Navigation has been suspended on the lower Missouri since the 4th, and at the end of the month the river is blocked by ice at its mouth.

Arkansas River. (Reported by J. J. O'Donnell, Fort Smith, Ark., and F. H. Clarke, Little Rock, Ark.)—The Arkansas River west of Fort Smith was below a navigable stage during the month, and continued about stationary until the 10th when precipitation caused a rise at Fort Smith from 0.9 foot on the 11th to 1.9 on the 12th, the river then falling until the 17th. Heavier precipitation caused a rise from 1.0 foot on the 16th to 2.5 feet on the 18th, this being the highest stage during the month and since August 31. After this rise the river was generally falling slowly until the end of the month, the highest rise being 0.3 foot on the 28th.

The lower Arkansas River continued too low for navigation to the 16th, when it had risen sufficiently to make navigation possible between Little Rock and Dardanelle, but below Little Rock the river continued low until the 26th, on which date the first boat from the mouth of the river reached Pinebluff. The lower river continued navigable the rest of the month. The average stage of the river was higher at Little Rock during the month than it has been since September. The river remained clear of ice throughout the month.

Red River. (Reported by C. Davis, Shreveport, La., and R. E. Kerkam, New Orleans, La.)—Moderately heavy rains in the watershed of the Red River from the 17th to the 21st caused the stream at Shreveport to reach and pass the zero of gauge on the 25th, it having been below that point since the first week of September. Consequent upon these conditions, navigation was resumed to a considerable extent near the end of the month. Heavy local rains in the valley of the extreme lower Red at various times caused a few marked fluctuations in the gauge readings at Alexandria. The Ouachita River rose during the greater part of the month, making navigation practicable during the last half of the month, and the stage at Monroe, La., was above 16 feet during the closing days of December.

Rivers on the Pacific Coast. (Reported by W. H. Hammon, San Francisco, Cal.; J. A. Barwick, Sacramento, Cal.; and B. S. Pague, Portland, Oreg.)—The rivers of California continued to fall slowly until the 8th when, owing to the rains on the 8th and 9th, there was a slight rise which reached its crest on the 9th. From this time to the end of the month the rivers fell slowly and stood at about the same stage on the 31st as they did on the 1st.

Owing to the lack of the usual rains the Sacramento River, at Sacramento, has remained comparatively low. Its stage was 10 feet at the beginning of the month, remaining nearly stationary to the 8th. A rise then set in, reaching a crest of 14.5 feet on the 9th, and afterward falling slowly to 10.3 feet at the close of the month. Low water at this point in December is not unusual as may be seen from the following tabular statement of December low waters:

Low waters in December at Sacramento, Cal.

Year.	Stage.	Year.	Stage.
	Feet.		*Feet.*
1880	7.6	1886	7.8
1881	7.7	1887	7.5
1883	7.0	1891	7.4
1884	7.5	1894	9.2

The Columbia, Snake, Willamette, and tributary rivers had nearly normal stages during the month. Owing to the influence of chinook winds on the 5th to 10th, and 26th to 29th, the rivers had a rise. From the 12th to 15th there was some danger of the lower docks in Portland flooding, but the river fell. During the second chinook, which was accompanied by heavy rain in western Washington, the small streams in that section rapidly flooded and much local damage was done, especially to railroad property. Navigation on the Willamette, from Portland 140 miles south, upon the Columbia, and upon the Snake was uninterrupted. There has been no freeze-up yet east of the Cascades, except in northern Idaho and northeastern Washington, and boats were in regular service.

Heights of rivers above zeros of gauges, December, 1897.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Paul, Minn. †	1,957	14	.....	.....	.....	.....	.....	.....
Reeds Landing, Minn.	1,887	12	1.0	22	0.2	4,10	0.6	0.8
La Crosse, Wis. †	1,822	10	.....	.....	.....	.....	.....	.....
North McGregor, Iowa	1,762	18	3.1	15–17	1.8	4	2.5	1.3
Dubuque, Iowa †	1,702	15	.....	.....	.....	.....	.....	.....
Leclaire, Iowa †	1,612	10	.....	.....	.....	.....	.....	.....
Davenport, Iowa [a]	1,596	15	4.3	20	— 0.5	1	1.1	4.8
Keokuk, Iowa [b]	1,466	14	0.3	17	— 2.0	6	—0.4	2.3
Hannibal, Mo	1,405	17	1.8	29–31	— 1.4	6	0.5	3.2
Grafton, Ill	1,307	23	5.2	31	0.1	9,10	2.5	5.1
St. Louis, Mo.	1,264	30	3.5	1	— 0.4	24	1.0	3.9

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River—Cont'd	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Chester, Ill.	1,189	30	1.8	1	— 1.9	24, 25	—0.4	3.7
Cairo, Ill	1,073	40	19.3	28	6.9	7	10.7	12.4
Memphis, Tenn	843	33	12.2	31	3.2	1	5.5	9.0
Helena, Ark	767	44	16.4	31	3.3	1	6.7	13.1
Arkansas City, Ark.	635	42	14.6	31	1.5	1	5.5	13.1
Greenville, Miss	595	40	11.1	31	1.3	1	4.3	9.8
Vicksburg, Miss	474	41	7.9	31	— 0.8	2	3.7	8.7
New Orleans, La	108	16	4.1	13	2.3	5,6	3.1	1.8
Arkansas River.								
Wichita, Kans.	720	10	1.7	14	0.8	1-12, 29, 30	1.1	0.9
Fort Smith, Ark.	345	22	2.5	18	0.6	7-9	1.4	1.9
Dardanelle, Ark.	250	21	2.6	19	— 0.6	1,5-12	0.6	3.2
Little Rock, Ark.	170	23	4.9	22	1.2	1-9	2.5	3.7
White River.								
Newport, Ark	150	26	4.7	24	0.4	1-3	2.0	4.3
Des Moines River.								
Des Moines, Iowa †	150	19	.....	.....	.....	.....	.....	.....
Illinois River.								
Peoria, Ill.	135	14	4.5	1	4.1	27-31	4.2	0.4
Missouri River.								
Bismarck, N. Dak.	1,201	14	4.6	29	2.7	12, 13	3.5	1.9
Pierre, S. Dak. †	1,006	14	.....	.....	.....	.....	.....	.....
Sioux City, Iowa †	676	19	.....	.....	.....	.....	.....	.....
Omaha, Nebr. †	561	18	.....	.....	.....	.....	.....	.....
St. Joseph, Mo.	373	10	0.7	24-26	— 2.7	6-8	—0.9	3.4
Kansas City, Mo. [a]	280	21	5.2	30	2.0	7,8	3.5	3.2
Boonville, Mo.	191	20	4.5	1	0.9	20	2.6	3.6
Hermann, Mo.	95	21	— 0.7	1	— 3.6	22	—2.3	2.9
Ohio River.								
Pittsburg, Pa	966	22	13.7	17	3.4	31	7.2	10.3
Davis Island Dam, Pa.	960	25	13.7	17	5.5	5,31	8.5	8.2
Wheeling, W. Va.	875	36	18.9	17	6.2	6	10.6	12.7
Parkersburg, W. Va.	785	35	18.0	19	7.7	29,30	11.6	10.3
Point Pleasant, W. Va.	703	36	19.1	22	6.6	31	12.2	12.5
Catlettsburg, Ky	651	50	22.8	23	9.0	31	15.0	13.8
Portsmouth, Ohio	612	50	23.2	23	10.2	31	15.7	13.0
Cincinnati, Ohio	499	45	25.5	22	12.0	1	17.8	13.5
Louisville, Ky.	367	24	10.1	23	6.0	1	8.0	4.1
Evansville, Ind	184	30	18.9	26	7.8	4	12.5	11.1
Paducah, Ky.	47	40	18.0	27	4.8	6	9.5	13.2
Alleghany River.								
Warren, Pa	177	7	5.4	16	1.2	5	2.7	4.2
Oil City, Pa	123	13	7.0	16	2.2	4,5	3.5	4.8
Parkers Landing, Pa.	73	20	8.0	16	1.7	31	3.7	6.3
Freeport, Pa.	26	20	13.1	16	3.8	31	6.9	9.3
Conemaugh River.								
Johnstown, Pa.	64	7	3.9	16	1.7	28, 29	2.5	2.2
Red Bank Creek.								
Brookville, Pa.	35	8	2.5	12	1.0	2-4, 29, 31	1.7	1.5
Beaver River.								
Ellwood Junction, Pa.	10	14	3.6	16	0.1	7-10	1.1	3.5
Cumberland River.								
Burnside, Ky	434	50	11.8	22	0.2	1,2	2.7	11.6
Carthage, Tenn.	257	30	12.8	24	0.8	2	4.3	12.0
Nashville, Tenn	175	40	16.4	24	1.3	1	6.6	15.1
Great Kanawha River.								
Charleston, W. Va.	61	30	8.0	22	3.7	29, 30	6.3	4.3
New River.								
Hinton, W. Va.	95	14	3.0	23	1.2	14	1.8	1.8
Licking River.								
Falmouth, Ky.	30	25	6.5	21	1.8	13, 14	2.9	4.7
Miami River.								
Dayton, Ohio	69	18	3.4	18	1.1	29	1.9	2.3
Monongahela River.								
Weston, W. Va.	161	18	9.6	5	— 1.0	10, 11	1.2	10.6
Fairmont, W. Va.	119	25	10.5	6	1.1	3,4	3.7	9.4
Greensboro, Pa.	81	18	17.0	5	7.7	3, 4, 13, 14	9.8	9.3
Lock No. 4, Pa.	40	28	20.6	6	7.2	4	10.6	13.4
Cheat River.								
Rowlesburg, W. Va.	36	14	9.0	5	2.5	2,3	4.1	6.5
Youghiogheny River.								
Confluence, Pa.	59	10	5.6	5	1.8	3	3.3	3.8
West Newton, Pa.	15	23	6.5	6	0.8	4	2.4	5.7
Muskingum River.								
Zanesville, Ohio	70	20	9.6	17	6.8	4, 10, 11	7.8	2.8
Tennessee River.								
Knoxville, Tenn.	614	29	3.5	23, 24	0.5	2,3	1.7	3.0
Kingston, Tenn	534	25	5.0	22	0.0	1-3	1.3	5.0
Chattanooga, Tenn	430	33	10.2	23	1.0	1	3.8	9.2
Bridgeport, Ala	390	24	8.2	24	0.0	1	2.4	8.2
Florence, Ala.	220	16	8.7	25	— 0.2	1,2	2.9	8.9
Johnsonville, Tenn.	94	21	13.3	25, 26	0.0	1,2	5.2	13.3

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Clinch River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Speers Ferry, Va.	156	20	1.5	23	— 0.7	1	0.1	2.2
Clinton, Tenn	46	25	7.0	23	2.0	1,2	3.9	5.0
Wabash River.								
Mount Carmel, Ill	50	15	7.4	20, 21	2.2	11	4.1	5.2
Red River.								
Arthur City, Tex.	688	27	3.6	20	2.1	1-3, 14-18	2.5	1.5
Fulton, Ark	565	28	4.6	31	1.0	1-10	2.1	3.6
Shreveport, La.	449	29	1.8	31	— 2.1	5-10	—1.1	3.9
Alexandria, La	139	33	6.3	27	— 2.8	1,2	1.7	9.1
Atchafalaya Bayou.								
Melville, La.	100*	31	14.4	27	2.3	1	9.2	12.1
Ouachita River.								
Camden, Ark.	340	39	15.0	24	3.5	1-3	6.6	11.5
Monroe, La	100	40	16.6	30	0.5	1,2	6.2	16.1
Yazoo River.								
Yazoo City, Miss.	80	25	11.5	27	— 2.1	1,2	5.9	13.6
Chattahoochee River.								
Columbus, Ga.	140	20	2.6	15	1.3	22, 24	1.8	1.3
Flint River.								
Albany, Ga.	80	20	3.2		1.1	1	2.1	2.1
Cape Fear River.								
Fayetteville, N. C.	100	38	10.0	28	3.0	14	5.1	7.0
Columbia River.								
Umatilla, Oreg	270	25	5.8	12-14	4.0	24, 25	5.0	1.8
The Dalles, Oreg.	166	40	10.0	14	5.9	26	7.9	4.1
Willamette River.								
Albany, Oreg	99	20	17.5	16	6.0	24, 25	10.4	11.5
Portland, Oreg	10	15	15.1	14, 15	6.0	23, 24	10.2	9.1
Edisto River.								
Edisto, S. C	75	6	3.8	31	2.3	16	2.8	1.5
James River.								
Lynchburg, Va.	257	18	1.7	16	— 0.1	1,2	0.7	1.8
Richmond, Va.	110	12	1.5	16	— 0.1	2-4	0.3	1.6
Alabama River.								
Montgomery, Ala.	265	35	5.3	25	— 0.7	2	2.2	6.0
Selma, Ala.	212	35	6.0	28	— 1.6	1	2.3	7.6
Coosa River.								
Gadsden, Ala [d]	144	18	6.3	24	— 0.2	1	2.2	6.5
Tombigbee River.								
Columbus, Miss.	285	33	11.5	23	— 3.6	1	5.0	15.1
Demopolis, Ala.	155	35	27.4	27	— 2.1	1,2	11.4	29.5
Black Warrior River.								
Tuscaloosa, Ala.	90	38	31.0	23	— 1.3	1	8.8	32.3
Pedee River.								
Cheraw, S. C.	145	27	4.5	28, 29	1.1	14	2.4	3.4
Black River.								
Kingstree, S. C.	60	12	5.3	31	2.4	6-10	3.4	2.9
Lumber River.								
Fairbluff, N. C.	10	6	1.7	31	0.2	1	0.7	1.5
Lynch Creek.								
Effingham, S. C.	35	12	5.7	28	3.3	1	4.0	2.4
Potomac River.								
Harpers Ferry, W. Va.	170	16	5.3	16	1.3	4	2.5	4.0
Roanoke River.								
Clarksville, Va.	155	12	0.4	23	0.1	3-21, 27-31	0.1	0.3
Sacramento River.								
Redbluff, Cal.	241	23	7.2	8	0.4	1,2	2.3	6.8
Sacramento, Cal.	70	25	14.9	13	9.7	6,7	11.7	5.2
Santee River.								
St. Stephens, S. C.	50	12	6.1	3	1.4	17	3.2	4.7
Congaree River.								
Columbia, S. C.	37	15	2.2	23	1.2	31	1.6	1.0
Wateree River.								
Camden, S. C.	45	24	6.0	28	3.0	13	4.1	3.0
Savannah River.								
Augusta, Ga.	130	32	7.9	1	5.9	13	6.9	2.0
Susquehanna River.								
Wilkesbarre, Pa.	178	14	9.0	17, 18	3.0	{2-6, 11-13, 24-31}	4.5	6.0
Harrisburg, Pa.	70	17	8.2	18	2.5	31	4.6	5.7
Juniata River.								
Huntingdon, Pa.	80	24	6.0	15	3.5	2-4	4.0	2.5
W. Br. of Susquehanna.								
Williamsport, Pa.	35	20	7.7	17	2.0	30	4.3	5.7
Waccamaw River.								
Conway, S. C.	40	7	2.2	3	0.4	12, 13, 18	1.0	1.8

* Distance to Gulf of Mexico. † Frozen. [a] Frozen, 21-31. [b] Frozen, 23-31. [c] Frozen, 5, 6, 20-25. [d] No observations, 17, 18.

SPECIAL CONTRIBUTIONS.

A PRELIMINARY DISCUSSION OF CERTAIN CYCLICAL CHANGES IN INDIA.

By W. L. DALLAS, Simla, India (dated December 8, 1897).

In the Indian Meteorological Memoirs, Vol. VI, it was shown by the author, and in a later volume of the same memoirs, by Mr. E. Douglas Archibald, that the effect on the course of barometric pressure of the periodic changes in the number of solar spots is to occasion a real variation in pressure of sufficient magnitude to enter into the discussion of the secular variations of weather. Having reached this conclusion, and it being evident both from present watching as well as from past records of weather, that the sun-spot influence alone was insufficient to account for the weather variations which are on record, it appeared to the writer desirable to carry the investigation a step further, and by eliminating the solar-spot influence to see whether there would then ap-